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FORM-PTO-1390 (Rev. 9-2001) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER
000515-283

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)
UNASSIGNED 10/019675

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/SE00/01404	3 July 2000	6 July 1999

TITLE OF INVENTION
METHOD AND DEVICE FOR FIBRE-OPTICAL MEASURING SYSTEMS

APPLICANT(S) FOR DO/EO/US
Nevio VIDOVIC, Martin KRANTZ, Svante HÖJER and Thorleif JOSEFSSON

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:
    International Preliminary Examination Report, Unexecuted Declaration

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U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5) 10/019675 UNASSIGNED	INTERNATIONAL APPLICATION NO PCT/SE00/01404	ATTORNEY'S DOCKET NUMBER 000515-283

				CALCULATIONS	PTO USE ONLY
21. ☒ The following fees are submitted:					
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO .... $1,040.00 (960) International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO .... $890.00 (970) International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO .... $740.00 (958) International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) .... $710.00 (956) International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00 (962)					
ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 1,040.00	
Surcharge of **$130.00 (154)** for furnishing the oath or declaration later than 20 ☐ 30 ☐ months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
Claims	Number Filed	Number Extra	Rate		
Total Claims	13 -20 =	-0-	X$18.00 (966)	$ -0-	
Independent Claims	3 -3 =	-0-	X$84.00 (964)	$ -0-	
Multiple dependent claim(s) (if applicable)			+ $280.00 (968)	$ -0-	
TOTAL OF ABOVE CALCULATIONS =				$ 1,040.00	
Reduction for 1/2 for filing by small entity, if applicable (see below). +				$ 520.00	-
SUBTOTAL =				$ 520.00	
Processing fee of **$130.00 (156)** for furnishing the English translation later than 20 ☐ 30 ☐ months from the earliest claimed priority date (37 CFR 1.492(f)). +				$ -0-	
TOTAL NATIONAL FEE =				$ 520.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00 (581)** per property +				$ -0-	
TOTAL FEES ENCLOSED =				$ 520.00	
				Amount to be refunded:	$
				charged:	$

a. ☒ Small entity status is hereby claimed.

b. ☒ A check in the amount of $ 520.00 to cover the above fees is enclosed.

c. ☐ Please charge my Deposit Account No. 02-4800 in the amount of $_______ to cover the above fees. A duplicate copy of this sheet is enclosed.

d. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-4800. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Kenneth B. Leffler
NAME

36,075
REGISTRATION NUMBER

January 4, 2002
DATE

10/019675
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Patent
Attorney's Docket No. 000515-283

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	
Nevio VIDOVIC et al.	Group Art Unit: UNASSIGNED
Application No.: UNASSIGNED	Examiner: UNASSIGNED
Filed: January 4, 2002	
For: METHOD AND DEVICE FOR FIBRE-OPTICAL MEASURING SYSTEMS	

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE CLAIMS:

Please amend claims 1 - 13 as follows:

1. (Amended) A method for optical measuring systems, comprising a sensor element connected to a measuring and control unit via an optical connection and being adapted for providing a signal corresponding to a measurement of a physical parameter influencing the sensor element, said method comprising

generation of a measuring signal that is brought to come in towards the sensor element, and

detection of said measuring signal in the measuring and control unit, after influencing the measuring signal in the sensor element,

characterized by the method further comprising:

partial reflection of the measuring signal at a point along the optical connection, located at a predetermined distance from the sensor element,

detection of the intensity of the signal corresponding to said partially reflected measuring signal, and

determination of a measurement of said parameter based upon the intensity of the partially reflected signal and the intensity of the measuring signal.

2. (Amended) The method according to claim 1, characterized by comprising:

determination of a value corresponding to the quotient of the intensity of said reflected signal and the intensity of said measuring signal, and

determination of a measurement of said parameter based upon said quotient.

3. (Amended) The method according to claim 1, characterized by comprising:

determination of a value corresponding to the difference between the intensity of said reflected signal and the intensity of said measuring signal, and

determination of a measurement of said parameter based upon said difference.

4. (Amended) A method according to claim 1, characterized by said measuring signal being a light pulse.

5. (Amended) A method according to claim 1, characterized by the feeding of the measuring signal into the sensor element causing optical interference in a cavity of the sensor element.

6. (Amended) A method according to claim 1, characterized by being used for measuring pressure, said sensor element defining a membrane, acted upon by the pressure surrounding the sensor element.

7. (Amended) A method according to claim 1, characterized by being used for measuring the acceleration or the temperature of said sensor element.

8. (Amended) A method for optical measuring systems, comprising a sensor element connected to a measuring and control unit via an optical connection and being adapted for providing a signal corresponding to a measurement of a physical parameter influencing the sensor element, said method comprising

generation of a signal which is brought to come in towards the sensor element, and

detection of said signal in said measuring and control unit after influencing the measuring signal in said sensor element,

characterized by the method further comprising determination of a measurement of the length of said optical connection, based upon a measured period of time elapsing from the generation of said signal until the detection of said signal.

9. (Amended) The method according to claim 8, characterized by said length determination being used for identification of the current type of sensor element, said length of said optical connection being selected to correspond to a specific type of sensor element.

10. (Amended) A device for optical measuring systems, comprising a sensor element connected to a measuring and control unit via an optical connection and being adapted for providing a signal corresponding to a measurement of a physical parameter influencing the sensor element, said device further comprising a light source functioning to generate a measuring signal brought to come in towards the sensor element, and a detector for detecting the intensity of the measuring signal in the measuring and control unit, after influencing the measuring signal in the sensor element,

characterized by comprising a semi-reflecting device for partial reflection of the measuring signal at a point along the optical connection at a predetermined distance from the sensor element, said detector being arranged for detection of the intensity of the signal corresponding to said partially reflected measuring signal, and by comprising an evaluation unit for determining a measurement of said parameter, based upon the intensity of the partially reflected signal and the intensity of the measuring signal.

11. (Amended) The device according to claim 10, characterized by said sensor element comprising a cavity, shaped so as to create optical interference when feeding said measuring signal into the cavity.

12. (Amended) The device according to claim 9, characterized by said cavity being obtained through building up molecular silicone and/or silicone dioxide layers, and an etching procedure.

13. (Amended) The device according to claim 12, characterized by said cavity being obtained through utilizing a bonding procedure.

REMARKS

The claims of the originally-filed application were drafted in accordance with a foreign patent practice. The claims are hereby amended merely to present an initial set of claims for examination that conform to U.S. patent practice.

Respectfully submitted,

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By:

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Date: January 4, 2002

Attachment to Preliminary Amendment dated January 4, 2002

Marked-up claims 1 - 13

1. (Amended) A method for optical measuring systems, comprising a sensor element [(6)] connected to a measuring and control unit [(10)] via an optical connection [(3)] and being adapted for providing a signal corresponding to a measurement of a physical parameter [(p)] influencing the sensor element [(6)], said method comprising

generation of a measuring signal that is brought to come in towards the sensor element [(6)], and

detection of said measuring signal [(B)] in the measuring and control unit [(10)], after influencing the measuring signal in the sensor element [(6)],

[characterised] characterized by the method further comprising:

partial reflection of the measuring signal at a point along the optical connection [(3)], located at a predetermined distance from the sensor element [(6)],

detection of the intensity of the signal [(A)] corresponding to said partially reflected measuring signal, and

determination of a measurement of said parameter [(p)] based upon the intensity of the partially reflected signal [(A)] and the intensity of the measuring signal [(B)].

2. (Amended) The method according to claim 1, [characterised] characterized by comprising:

determination of a value corresponding to the quotient of the intensity [(I_A)] of said reflected signal [(A)] and the intensity [(I_B)] of said measuring signal [(B)], and

determination of a measurement of said parameter [(p)] based upon said quotient [(I_A/I_B)].

3. (Amended) The method according to claim 1, [characterised] characterized by comprising:

Attachment to Preliminary Amendment dated January 4, 2002

Marked-up claims 1 - 13

determination of a value corresponding to the difference between the intensity [(I_A)] of said reflected signal [(A)] and the intensity [(I_B)] of said measuring signal [(B)], and

determination of a measurement of said parameter [(p)] based upon said difference [(I_A-I_B)].

4. (Amended) A method according to [any one of the preceding claims] claim 1, [characterised] characterized by said measuring signal [(B)] being a light pulse.

5. (Amended) A method according to [any one of the preceding claims] claim 1, [characterised] characterized by the feeding of the measuring signal into the sensor element [(6)] causing optical interference in a cavity [(6a)] of the sensor element [(6)].

6. (Amended) A method according to [any one of the preceding claims] claim 1, [characterised] characterized by being used for measuring pressure [(p)], said sensor element [(6)] defining a membrane [(6b)], acted upon by the pressure [(p)] surrounding the sensor element [(6)].

7. (Amended) A method according to [any one of the preceding claims] claim 1, [characterised] characterized by being used for measuring the acceleration or the temperature of said sensor element [(6)].

8. (Amended) A method for optical measuring systems, comprising a sensor element [(6)] connected to a measuring and control unit [(10)] via an optical connection [(3)] and being adapted for providing a signal corresponding to a measurement of a physical parameter [(p)] influencing the sensor element [(6)], said method comprising

generation of a signal which is brought to come in towards the sensor element [(6)], and

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Marked-up claims 1 - 13

detection of said signal in said measuring and control unit [(10)] after influencing the measuring signal in said sensor element [(6)],

[characterised] characterized by the method further comprising determination of a measurement of the length of said optical connection [(3)], based upon a measured period of time elapsing from the generation of said signal until the detection of said signal.

9. (Amended) The method according to claim 8, [characterised] characterized by said length determination being used for identification of the current type of sensor element [(6)], said length of said optical connection [(3)] being selected to correspond to a specific type of sensor element [(6)].

10. (Amended) A device for optical measuring systems, comprising a sensor element [(6)] connected to a measuring and control unit [(10)] via an optical connection [(3)] and being adapted for providing a signal corresponding to a measurement of a physical parameter [(p)] influencing the sensor element [(6)], said device further comprising a light source [(2)] functioning to generate a measuring signal brought to come in towards the sensor element [(6)], and a detector [(7)] for detecting the intensity of the measuring signal [(B)] in the measuring and control unit [(10)], after influencing the measuring signal in the sensor element [(6)],

[characterised] characterized by comprising a semi-reflecting device [(12)] for partial reflection of the measuring signal at a point along the optical connection [(3)] at a predetermined distance from the sensor element [(6)], said detector [(7)] being arranged for detection of the intensity of the signal [(A)] corresponding to said partially reflected measuring signal, and by comprising an evaluation unit [(9)] for determining a measurement of said parameter [(p)], based upon the intensity of the partially reflected signal [(A)] and the intensity of the measuring signal [(B)].

Attachment to Preliminary Amendment dated January 4, 2002

Marked-up claims 1 - 13

11. (Amended) The device according to claim 10, [characterised] characterized by said sensor element [(6)] comprising a cavity [(6a)], shaped so as to create optical interference when feeding said measuring signal into the cavity [(6a)].

12. (Amended) The device according to claim 9, [characterised] characterized by said cavity [(6a)] being obtained through building up molecular silicone and/or silicone dioxide layers, and an etching procedure.

13. (Amended) The device according to claim 12, [characterised] characterized by said cavity [(6a)] being obtained through [utilising] utilizing a bonding procedure.

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TITLE:

Method and device for measuring system

TECHNICAL FIELD

The present invention relates to a method for measuring systems according to the preamble of the appended claim 1. The invention is especially intended for use with intensity-based fibre-optical measuring systems for pressure measurements. The invention also relates to a device for carrying out such a method, according to the preamble of the appended claim 10.

BACKGROUND ART

In connection with measuring physical parameters such as pressure and temperature, it is previously known to utilise various sensor systems by which the optical intensity of a ray of light, conveyed through an optical fibre and coming in towards a sensor element, is influenced due to changes in the respective physical parameter. Such a system may for example be used when measuring the blood pressure in the veins of the human body. Said system is based upon a transformation from pressure to a mechanical movement, which in turn is transformed into an optical intensity, conveyed by an optical fibre, which is in turn transformed into an electrical signal that is related to the measured pressure.

According to known art, such a fibre-optical measurement system may comprise a pressure sensor, an optical fibre connected to said pressure sensor, and at least one light source and at least one light detector located at the opposite end of the fibre, in order to provide the pressure sensor with light, and to detect the information-carrying light signal returning from the pressure sensor, respectively.

One problem occurring with previously known systems of the above kind relates to the fact that the detected signal will be influenced by various interference factors in connection with the measuring system. For example, the signal may be influenced by any bending of the optical fibre, and by temperature changes and ageing of the optical fibre or of said light source. Also factors such as fibre couplings and fibre connectors in the measuring system in question may influence the information-

carrying signal (for example through influencing its intensity in an unwanted manner) and thus also the final measuring result.

As a result of the above problems there is a need for devices and methods arranged for compensation of any existing sources of error and interference in connection with optical measurements of for example pressure.

There are several previously known measuring systems in which a measuring signal is used together with a separate reference signal. A certain measuring system category is based upon conveying light through two different optical fibres, and is used for said purpose. One example of such a system is shown in the patent document US 5,657,405, which describes a fibre-optical measuring system used for measuring of e.g. pressure. In this system, the interference occurring between two optical conduits through which two corresponding laser light signals are directed towards a membrane, is utilised. One of these light signals is hereby used as a reference signal.

Another previously known category of systems is based on generating and utilising light of two different wavelengths, whereby a reference signal may be obtained. Systems of this kind are previously known from for example the patent documents US 5,280,173 and US 4,933,545.

One disadvantage with the systems according to the two categories mentioned above is that they are relatively complex in their structure. They further require a relatively large number of critical components in the form of LED:s, optical fibres, etc.

DISCLOSURE OF INVENTION

A primary object of the present invention is to provide an improved measuring system, with the aid of which unwanted influences from sources of error and interference in intensity-based fibre-optical measuring systems can be minimised. This is achieved by means of a method and a device in accordance with the present invention, the characteristics of which are defined in the accompanying claims 1 and 10, respectively.

The invention is intended for use in optical measurement systems comprising a sensor element connected to a measuring and control unit via an optical connection, and that are adapted for providing a signal corresponding to a measurement of a physical parameter acting upon the sensor element. The invention consists of a method comprising the generation of a measuring signal that is brought to come in towards the sensor element, and the detection of the intensity of the measuring signal in the measuring and control unit, after influencing the measuring signal in the sensor element. The invention is characterised by comprising partial reflection of the measuring signal at a point along the optical connection, at a predetermined distance from the sensor element, detection of the intensity of the signal corresponding to said partially reflected measuring signal, and determination of a measurement of said parameter based on the intensity of the partially reflected signal and the intensity of the measuring signal.

Through the invention a substantial advantage is achieved, as it can be utilised in a simple and effective manner for compensation of sources of error and interference by intensity-based optical measurements of e.g. pressure.

It is a further object of the invention to provide a method for an optical measuring system, wherein a signal is brought to come in towards a sensor element, and wherein a measurement of the length of an optical connection between said sensor element and a measuring and control unit can be determined in a simple and efficient manner. This measurement can in turn be used to obtain improved measurements. This object is achieved by means of a method, the characteristics of which are defined in the accompanying claim 8.

Said method is based especially upon a determination of a measurement of the length of said optical connection, based on a measured period of time passing from the generation of said signal and up to the detection of said signal. With such a method, the length determination may be used for identification of which sensor element that is currently being connected to the subject measuring and control unit. Hereby, the length of the optical connection is chosen so as to correspond to a specific type of sensor element.

Advantageous embodiments of the invention are defined by the subsequent dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

The invention will be explained in more detail below, with reference to a preferred embodiment and to the enclosed drawings, in which:

Fig. 1 shows, schematically, a measuring system according to the present invention;

Fig. 1a shows an enlarged view of a sensor element suitable for use in connection with the invention; and

Fig. 2 shows a graph illustrating how light signals are detected according to the invention.

PREFERRED EMBODIMENTS

Fig. 1 shows, schematically and somewhat simplified, an intensity-based fibre-optical measuring system 1 according to the present invention. According to a preferred embodiment, the measuring system is designed for pressure measurements, but alternatively, the invention could be used e.g. for measuring temperature or acceleration.

To the measuring system 1 belongs a light source in the form of an LED 2 functioning to emit a light signal of a predetermined wavelength λ_1. The LED 2 is connected to an optical connection, preferably in the form of an as such previously known optical fibre 3, by means of a first link 4 and a fibre coupling 5. The optical fibre 3 is in turn connected to a sensor element 6.

According to what is shown in detail by Fig. 1a, which is an enlarged view of the sensor element 6, said element comprises a cavity 6a, for example obtainable (according to known art) through construction by means of molecular layers (primarily silicone, alternatively silicone dioxide or a combination of the two) and an etching procedure. Preferably, a bonding procedure is also utilised in assembling the various layers of the sensor element 6. The manufacture of such a sensor element 6 is as such previously known, e.g. from the Patent Document PCT/SE93/00393. In this

way, a membrane 6b is also created within the sensor element 6, the deflection of which membrane will depend on the pressure p influencing the sensor element 6.

According to what will be described in detail below, the above light signal will be brought to come in towards the pressure sensor 6, i.e. towards its cavity 6a. Hereby, the pressure p acting on the membrane 6b will modulate the light signal. When the membrane 6b is influenced by a certain pressure p, the dimensions of the cavity 6a, primarily its depth d, will change, entailing a modulation of the light signal through optical interference inside the cavity 6a.

When designing the sensor element 6, the depth d of the cavity 6a is selected to be a value of substantially the same magnitude as the wavelength λ_1 of the light signal. The sizing of the cavity 6a is further made considering the required application area for the sensor element 6, in the current case primarily the pressure range to which the sensor element 6 is to be adapted.

According to the invention, the light signal consists of a pulse of relatively short duration. In normal applications, using an optical fibre 3 with a length of about 2-10 m, the pulse duration is in the order of 10-50 ns. However, the invention is not so limited, but could also be realised with a pulse length deviating from this interval. For example, pulses of longer duration are used in those cases where very long optical fibres (e.g. 100-200 m) are used.

The light pulse thus defines a measuring signal that is transmitted through the fibre 3 and fed into the sensor element 6. The light pulse will be modulated in the manner described above by means of the cavity 6a and is thereby provided with information corresponding to the current pressure p. The light signal modulated by the sensor element 6 is then transmitted back through the fibre 3 and conveyed to a light-sensitive detector 7, through said fibre coupling 5 and a further fibre link 8. The detector 7 is functioning to detect, in a known manner, the intensity of the reflected measuring signal.

For processing of the light signal detected by the detector 7, the measuring system according to the invention also comprises an evaluation unit 9. The evaluation unit 9

thus defines, together with the LED 2, the links 4, 8, the coupling 5 and the detector 7, a measuring and control unit 10, which in turn is connected to a presentation unit 11, e.g. in the form of a display, by the aid of which a measurement of the current pressure p can be visualised for a user.

The two links 4, 8 preferably consist of optical fibres of an as such known kind, the fibre coupling 5 thereby comprising an as such known fibre junction device designed so as to transfer the two fibre links 4, 8 into the fibre 3 leading to the sensor element 6.

It is a basic principle behind the invention that a semi-reflecting device 12 is provided along the optical fibre 3, at a predetermined distance from the sensor element 6. This device 12, according to the embodiment, consists of a so-called ferrule, i.e. a separate, tube-like unit for interconnection of optical fibres, arranged in such a manner that the light pulse emitted from the LED 2 will be partially reflected back to the detector 7, i.e. without having run up to and being influenced by the sensor element 6. The optical connection 3, according to the embodiment, is thus in practice comprised of a first optical conductor 3a that is coupled to a second optical conductor 3b via said ferrule 12. Between the two optical conductors 3a, 3b, a small air gap is hereby provided by means of the ferrule, at which gap said partial reflection will occur.

The invention is not limited to the reflecting device 12 described above. Alternatively, other forms of mirrors, or reflecting coatings and surfaces, may be used to provide a partially reflecting device creating the described light reflection.

Out of the light pulse emitted by the LED 2, two returning light pulses are thus created, i.e. a measuring signal that reaches the sensor element 6 and is then returned, and a reference signal that is returned directly at the reflecting device 12.

The returning light signals will run, via the fibre coupling 5, into the second fibre link 8 and to the detector 7. The detector 7 will hereby detect the intensity of the measuring signal and the reference signal, respectively. Because the reflecting device 12 is arranged at a predetermined distance from the sensor element 6, the reference

signal will reach the light detector 7 a short time period before the measuring signal, reflected at the sensor element 6, will reach the light detector 7. The time period elapsing between the detection of the two signals will hereby depend on the position along the optical fibre 3 at which the reflecting device 12 is arranged, i.e. said period of time will depend on the distance between the reflecting device 12 and the sensor element 6.

With reference to Fig. 2, there is shown, schematically, how two pulses generated in the above manner are detected by means of the detector 7. Fig. 2 thus illustrates the intensity I of the detected pulses, as a function of time t. From the figure it can be gathered that a first pulse A, resulting from the above light signal being reflected against the reflecting device 12, reaches the detector 7, said detector 7 hereby being adapted to determine a value of the intensity I_A of said pulse A. Furthermore, a second pulse B is coming in towards the detector 7 a certain period of time t_1 after the first pulse A having reached the detector 7. The intensity I_B of the second pulse B is also detected by the detector 7. The second pulse B hereby corresponds to the above measuring signal, i.e. a light signal having been modulated in the sensor element 6 and thus containing information regarding the pressure p acting on the sensor element 6 (compare Fig. 1a).

Furthermore, the evaluation unit 9 is adapted to calculate the quotient of the two intensity values of the respective pulses, that is I_A/I_B. Through the invention, a measurement is thus obtained, where the measuring signal (i.e. the second pulse B) defines a measurement of the pressure p, including the effects of any sources of error, and where the reference signal (i.e. the first pulse A) only corresponds to the effects of any sources of error. Through calculating said quotient, a measurement of the current pressure is obtained, where factors reflecting sources of error and interference have thus been compensated for. This is of course an advantage, as it will lead to less interference-sensitive measurements. As examples of unwanted sources of error, any bending of the optical fibre, temperature changes and ageing of the optical fibre or the LED 2, may be mentioned, as well as any changes occurring in the fibre coupling 5.

In essence, it applies that the first pulse A defines a reference signal that can be used to compensate for the effects of any interference in connection with measurements with the measuring system according to the invention.

In order to be able to separate the two pulses A and B during detection in the detector 7, it is required that the period of time t_1 exceeds a minimum limit value. This limit value is depending on how high a resolution that can be achieved with the aid of the measuring and control unit 10. For normal applications, this limit value t_1 is in the order of 10 ns. For normal applications, with optical fibres of the length 2-10 m, it is therefore suitable that the reflecting device 12 is located at about half the distance between the measuring and control unit 10 and the sensor element 6.

According to a variant of the invention (not shown in the figures), the latter can be arranged so as to send one single pulse to two or more branches, in turn comprising two or more optical fibres with a corresponding number of sensor elements. Along each one of the optical fibres, a reflecting device of the above kind will then be provided. By means of suitable location of the respective reflecting devices along each optical fibre, reference signals and measuring signals from each branch can be obtained and detected at predetermined intervals. In this connection, the length of each optical fibre and the location of each individual mirror device must be adapted in such a way that all measuring and reference signals can be individually separated. These signals can then be detected and evaluated in a manner analogous with the above description.

With the aim of providing an especially efficient pressure measurement, the invention could be used for detection of the periods of time elapsing from the generation of a certain light pulse at the LED 2 until it is detected in the detector 7. By means of measured values of such periods of time (and with knowledge of the propagation velocity of the light pulses along the optical connection 3 in question) a measurement of the length of the optical connection between the measuring and control unit 10 and the reflecting device 12, and between the measuring and control unit 10 and the sensor element 6, respectively, can be calculated. If the individual sensor element 6 is fitted to an optical connection given a predetermined, unique length, this type of detection can be utilised for carrying out an identity check of the individual

sensor element. For example, a measured length of the optical connection of 2 m could hereby be said to correspond to a first type of sensor element, whereas a measured length of the optical connection of 3 m could correspond to a second type of sensor element. In this way, the invention could be used in such a manner that the measuring and control unit 10, by detecting the length of a certain optical connection, first identifies what type of sensor element is currently connected. Subsequently, the measuring and control unit 10 may, during the continued measurements, utilise for example information regarding calibration and other similar data, specifically relating to the currently connected sensor element. This type of information would hereby preferably be pre-stored in the measuring and control unit 10 and be used for the individual sensor elements that a specific measuring and control unit 10 is intended to be used with. Through introducing, for example, data regarding the calibration of a specific sensor element to be introduced into the measurements, the invention thus allows improved measurements.

The invention is not limited to the embodiment described above, but may be varied within the scope of the appended claims. For example, the principle behind the invention could be used also for systems not intended for pressure measurements.

Instead of a calculation of the quotient of two intensity values of two light signals, i.e. I_A/I_B (according to the description above), a calculation of the difference (I_A-I_B) between said two values could be performed in the measuring and control unit. Also in this case, a compensation for any sources of error and interference is obtained. According to a further conceivable solution, the two light signals I_A, I_B could be comprised as input parameters in an appropriately formed function, by the aid of which a compensation for sources of error would be provided.

CLAIMS

1. A method for optical measuring systems, comprising a sensor element (6) connected to a measuring and control unit (10) via an optical connection (3) and being adapted for providing a signal corresponding to a measurement of a physical parameter (p) influencing the sensor element (6), said method comprising

generation of a measuring signal that is brought to come in towards the sensor element (6), and

detection of said measuring signal (B) in the measuring and control unit (10), after influencing the measuring signal in the sensor element (6),

characterised by the method further comprising:

partial reflection of the measuring signal at a point along the optical connection (3), located at a predetermined distance from the sensor element (6),

detection of the intensity of the signal (A) corresponding to said partially reflected measuring signal, and

determination of a measurement of said parameter (p) based upon the intensity of the partially reflected signal (A) and the intensity of the measuring signal (B).

2. The method according to claim 1, characterised by comprising:

determination of a value corresponding to the quotient of the intensity (I_A) of said reflected signal (A) and the intensity (I_B) of said measuring signal (B), and

determination of a measurement of said parameter (p) based upon said quotient (I_A/I_B).

3. The method according to claim 1, characterised by comprising:

determination of a value corresponding to the difference between the intensity (I_A) of said reflected signal (A) and the intensity (I_B) of said measuring signal (B), and

determination of a measurement of said parameter (p) based upon said difference (I_A-I_B).

4. A method according to any one of the preceding claims, characterised by said measuring signal (B) being a light pulse.

5. A method according to any one of the preceding claims, characterised by the feeding of the measuring signal into the sensor element (6) causing optical interference in a cavity (6a) of the sensor element (6).

6. A method according to any one of the preceding claims, characterised by being used for measuring pressure (p), said sensor element (6) defining a membrane (6b), acted upon by the pressure (p) surrounding the sensor element (6).

7. A method according to any one of the preceding claims, characterised by being used for measuring the acceleration or the temperature of said sensor element (6).

8. A method for optical measuring systems, comprising a sensor element (6) connected to a measuring and control unit (10) via an optical connection (3) and being adapted for providing a signal corresponding to a measurement of a physical parameter (p) influencing the sensor element (6), said method comprising

generation of a signal which is brought to come in towards the sensor element (6), and

detection of said signal in said measuring and control unit (10) after influencing the measuring signal in said sensor element (6),

characterised by the method further comprising determination of a measurement of the length of said optical connection (3), based upon a measured period of time elapsing from the generation of said signal until the detection of said signal.

9. The method according to claim 8, characterised by said length determination being used for identification of the current type of sensor element (6), said length of said optical connection (3) being selected to correspond to a specific type of sensor element (6).

10. A device for optical measuring systems, comprising a sensor element (6) connected to a measuring and control unit (10) via an optical connection (3) and being adapted for providing a signal corresponding to a measurement of a physical parameter (p) influencing the sensor element (6), said device further comprising a light source (2) functioning to generate a measuring signal brought to come in towards the sensor element (6), and a detector (7) for detecting the intensity of the measuring signal (B) in the measuring and control unit (10), after influencing the measuring signal in the sensor element (6),

c h a r a c t e r i s e d b y comprising a semi-reflecting device (12) for partial reflection of the measuring signal at a point along the optical connection (3) at a predetermined distance from the sensor element (6), said detector (7) being arranged for detection of the intensity of the signal (A) corresponding to said partially reflected measuring signal, and by comprising an evaluation unit (9) for determining a measurement of said parameter (p), based upon the intensity of the partially reflected signal (A) and the intensity of the measuring signal (B).

11. The device according to claim 10, c h a r a c t e r i s e d b y said sensor element (6) comprising a cavity (6a), shaped so as to create optical interference when feeding said measuring signal into the cavity (6a).

12. The device according to claim 9, c h a r a c t e r i s e d b y said cavity (6a) being obtained through building up molecular silicone and/or silicone dioxide layers, and an etching procedure.

13. The device according to claim 12, c h a r a c t e r i s e d b y said cavity (6a) being obtained through utilising a bonding procedure.

ABSTRACT

The invention relates to a method for optical measuring systems, comprising a sensor element (6) connected to a measuring and control unit (10) via an optical connection (3), and being adapted for providing a signal defining a measurement of a physical parameter (p) influencing the sensor element (6), said method comprising generation of a measuring signal that is brought to come in towards the sensor element (6), and detection of the intensity of the measuring signal (B) in the measuring and control unit (10), after influencing the measuring signal in the sensor element (6). The invention is characterised by comprising partial reflection of the measuring signal at a point along the optical connection (3), at a predetermined distance from the sensor element (6), detection of the intensity of the signal (A), corresponding to said partially reflected measuring signal, and determination of a measurement of said parameter (p) based upon the intensity of the partially reflected signal (A) and the intensity of the measuring signal (B). The invention also relates to a device for carrying out said method. Through the invention, measurements with an optical pressure measuring system are allowed, which exhibit effective compensation for any existing sources of error.

(Fig. 1)

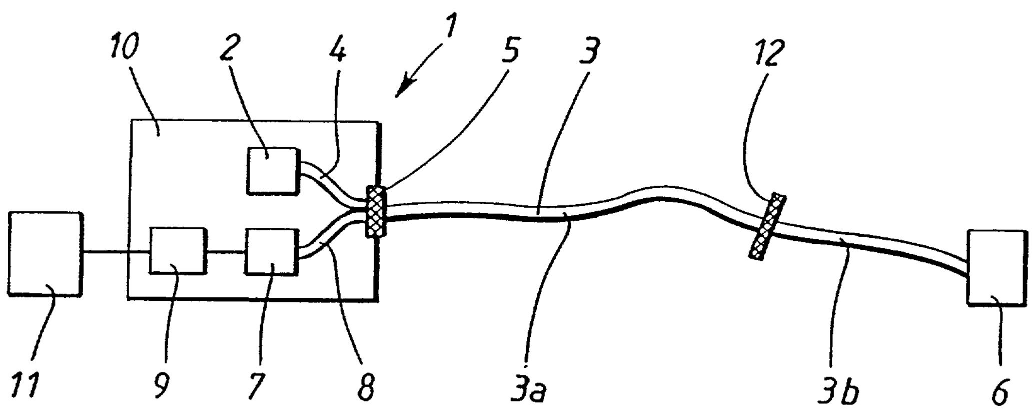

FIG.1

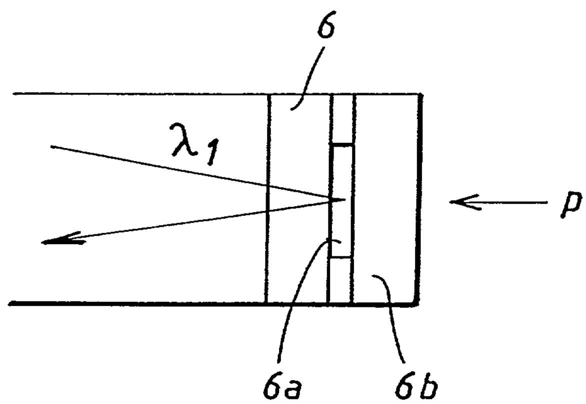

FIG.1a

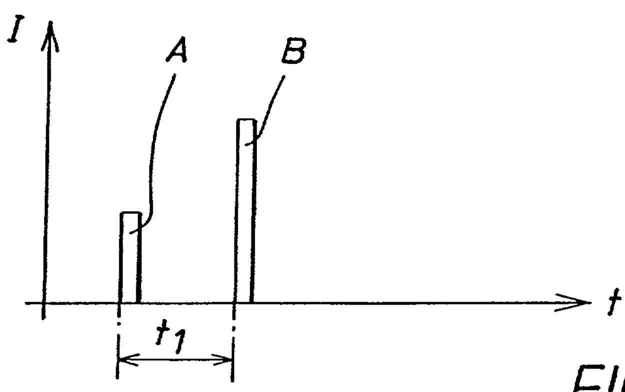

FIG.2

000515-283
Attorney's Docket No.

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY
(Includes Reference to PCT International Applications)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND DEVICE FOR FIBRE-OPTICAL MEASURING SYSTEMS

the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application
Number ______________ on ______________
and was amended on ______________ (if applicable).

☒ was filed as PCT international application
Number PCT/SE00/01404 on July 3, 2000
and was amended on January 4, 2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. §119(a)-(d):				
COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. §119	
SWEDEN	9902590-0	6 July 1999	X Yes	No
			Yes	No
			Yes	No
			Yes	No
			Yes	No

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00

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Combined Declaration and Power of Attorney
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Attorney's Docket No. 000515-282

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